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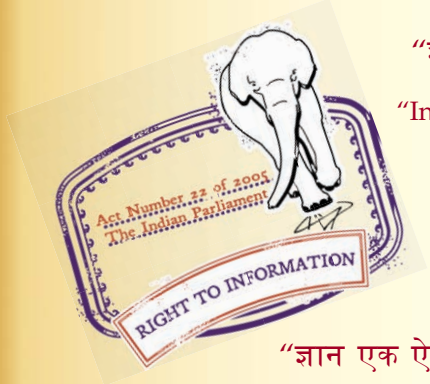

"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS : 6089 (Part I) - 1971
(Reaffirmed 2002)

Indian Standard

SPECIFICATION FOR SENSITIVE SWITCHES

PART I GENERAL REQUIREMENTS AND TESTS

UDC 621·316·542-181·4 : 621·38/·39·03

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

Price Rs 8·50

December 1971

Indian Standard

SPECIFICATION FOR SENSITIVE SWITCHES

PART I GENERAL REQUIREMENTS AND TESTS

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SPECIFICATION FOR SENSITIVE SWITCHES

PART I GENERAL REQUIREMENTS AND TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 8 February 1971, after the draft finalized by the Electromechanical Components for Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 The object of this standard is to establish uniform requirements for the electrical, mechanical, climatic properties and test methods for sensitive switches normally intended for use in electronic and telecommunication equipment. Such switches normally require a small actuating force applied over a small distance to provide for the snap action.

0.3 This part of the standard covers the general requirements and methods of measurements. Subsequent parts will contain the individual specifications for different types of sensitive switches.

0.4 While preparing this document assistance has been derived from the following specifications:

IEC Publication 163-1 and 163-1A (1968) Sensitive switches: Part I General requirements and measuring methods. International Electrotechnical Commission.

BS 9562:1970 Microswitches (sensitive switches) of assessed quality: Generic data and methods of test. British Standards Institution.

0.5 This standard requires reference to IS:589-1961*. So far as the details of the climatic and mechanical testing procedures are concerned; only the relevant degrees of severity have been specified in this standard.

0.6 This standard is one of a series of Indian standards on electromechanical components for electronic equipment. Other standards published so far in the series are given on P 30.

0.7 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS:2-1960†.

*Basic climatic and mechanical durability tests for electronic components (*revised*).
†Rules for rounding off numerical values (*revised*).

The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I) prescribes general requirements and methods of tests for judging the mechanical, electrical and climatic properties of sensitive switches intended for use in electronic and telecommunication equipment.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Sensitive Switch — A switch having a snap action mechanism operated by application of a small specified force through a small specified distance. The resulting indirect contacting action may be such that the speed of contacting is independent of the speed of the actuation.

2.2 Actuator — The integral part of the sensitive switch to which an external mechanical force is to be applied. Movement of the actuator causes the snap action mechanism to function.

2.3 Auxiliary Actuator — An adaptor designed to be mounted on a sensitive switch so that the switch may be operated by means of the actuating force applied to the adaptor.

2.4 Position — The position of the actuator which results in a particular circuit condition. A position may be momentary or maintained when the actuator is released.

2.5 Free Position (Fig. 1A) — The position of the actuator or auxiliary actuator when no external mechanical force is applied to it.

2.6 Operating Position (Fig. 1B) — The position of the actuator or auxiliary actuator, at the instant when an increasing applied force has just caused the snap action mechanism to operate.

2.7 Released Position (Fig. 1D) (for Biased Switches) — The position of the actuator or auxiliary actuator, at the instant when a decreasing applied force allows the snap action mechanism to revert to its initial state.

2.8 Reset Position (for Non-biased Switches) — The position of the reset actuator, or auxiliary actuator at the instant when an increasing applied force causes the snap action mechanism to revert to its initial state.

2.9 Total Travelled Position (Fig. 1C) — The position of the actuator, or auxiliary actuator, when an increasing applied force has caused it to move to the actual limit of the permissible travel.

2.10 Pretravel (Fig. 1B) — The distance between the free position and the operating position.

2.11 Overtravel (Fig. 1C) — The distance between the operating position and the total travelled position.

2.12 Movement Differential (Fig. 1D) — The distance between the operating position and the release position.

2.13 Total Travel (Fig. 1C) — The distance which is the sum of the pretravel and overtravel.

2.14 Release Travel (Fig. 1D) — The distance between the release position and the free position.

2.15 Actuating Force — That force which must be applied to the actuator, or auxiliary actuator, to cause it to move from the free position to the operating position.

2.16 Release Force — The value to which the actuating force must be reduced in order to permit the switch to return to its normal position after operation.

2.17 Reset Force — That force which must be applied to the reset actuator or auxiliary actuator, to cause it to move from its free position to the reset position.

2.18 Force Differential — The difference between the actuating force and the release force.

2.19 Total Overtravel Force — The force necessary to move the actuator, or auxiliary actuator, from the free position to the total travelled position.

2.20 Contact Actions — The nature of operations executed by the contacts. The contact actions normally to be envisaged are:

a) *Make* — Contacts close with actuator or auxiliary actuator in operating position.

b) *Break* — Contacts open with actuator or auxiliary actuator in operating position.

c) *Changeover* — A contact unit having a contact member common to two contact circuits one of which is open and the other closed when the actuator or auxiliary actuator is not operated.

2.21 Clearance — The shortest distance measured in air between conductive parts.

2.22 Creepage Distance — The shortest distance over the outer surface of the insulation between conductive parts with the switch in any set position.

2.23 Electrical Ratings — The electrical ratings of a switch are given for specified circuits by the combination of voltage and current under which the switch shall operate satisfactorily under standard atmospheric conditions for testing.

2.24 Rated Voltage (U_R) and Rated Current (I_R) — The maximum voltage and the current which the contacts are capable of interrupting for the specified number of operations at the rated load.

2.25 Transit Time

2.25.1 *Transit Time for Switches with 3 or 4 Terminations per Pole (Changeover Switches)* — The time interval between the instant when the moving contact leaves one fixed contact and the instant when it first reaches the other fixed contact. For switches of more than one pole, transit time shall be calculated from the first break to the last make.

2.25.2 *Transit Time for Switches with Two Terminations per Pole (On/Off Switches* — Either of the following definitions apply, as appropriate:

a) The time interval between the instant when the snap action mechanism operates and the instant when the contact is made. For switches of more than one pole, transit time shall be calculated to the last make.

b) The time interval between the instant when contact is broken and the instant when the moving contact reaches the end stop. For switches of more than one pole transit time shall be calculated from the first break.

2.26 Type — Identification given to variants of switches of the same designation, all switches of each such variant having similar design features and manufactured by the same techniques.

2.27 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general qualities and design of a given type of switch.

2.28 Acceptance Tests — Tests carried out on samples selected from a lot for purposes of verifying the acceptability of the lot.

2.28.1 *Lot* — All sensitive switches of the same type, category and rating manufactured by the same factory during the same period using the same process and materials.

2.29 Routine Tests — Test carried out on each switch to check requirement which are likely to vary during production.

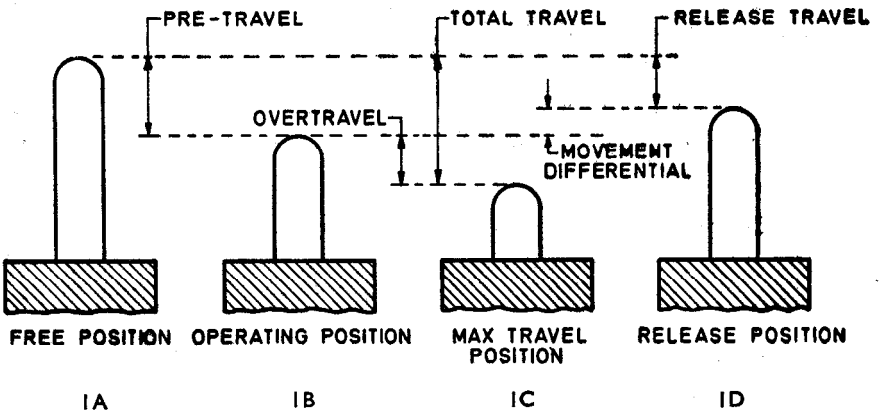

FIG. 1 DIAGRAM OF SWITCH POSITIONS

3. CATEGORIES

3.1 There shall be three categories corresponding to their ability to withstand the climatic severities listed below:

Climatic Test (*See* IS : 589-1961*)	*Severities*		
	Category I	Category II	Category III
Dry heat	100°C	85°C	70°C
Cold	−55°C	−40°C	−10°C
Damp heat (long term)	56 days	56 days	21 days
Damp heat (accelerated)	6 cycles	6 cycles	2 cycles
Rapid change of temperature	+100°C to −55°C	+85°C to −40°C	—
Low air pressure	44 mbar	85 mbar	600 mbar

NOTE — In case of special requirements where the above categories cannot be applied, different combinations of climatic serverities may be agreed to between the purchaser and the supplier provided that the degrees of severities are chosen from those specified in IS : 589-1961*.

*Basic climatic and mechnical durability tests for electronic components (*revised*).

4. MATERIALS AND WORKMANSHIP

4.1 Materials — The switches shall be constructed from the most suitable materials which should be free from flaws and shall conform to the relevant Indian Standard Specification, if any.

4.1.1 When dissimilar metals are used in intimate contact with each other, protection against electrolysis and corrosion shall be provided. The use of dissimilar metals in contact, which tends towards active electrolytic corrosion (particularly brass, copper and steel used in contact with aluminium or aluminium alloy) is not acceptable. However, metal plating or metal spraying of dissimilar base metals to provide similar or suitable abutting surface is permitted.

4.2 Workmanship — All parts of the switch shall be manufactured and processed in a careful and workmanlike manner in accordance with good engineering practice.

5. ELECTRICAL RATINGS

5.1 The relevant specification for sensitive switches shall include the following electrical ratings:

a) Rated voltage,

b) Rated current, and

c) Circuit condition and associated combinations of voltage and current.

6. MARKING

6.1 Each sensitive switch shall be clearly marked with the following information in the order of preference given below:

a) Manufacturer's name/trade-mark,

b) Manufacturer's type number or code number,

c) Electrical ratings,

d) Category of the switch,

e) Identification of contacts (preferably with circuit diagram if space permits),

f) Country of manufacture, and

g) Any additional requirments if required by the purchaser.

6.2 The sensitive switches or their cartons may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act, and the Rules and Regulations made thereunder. Presence of this mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard, under a well-defined system of inspection, testing and quality control during production. This system, which is devised and supervised by ISI and operated by the producer, has the further safeguard that the products as actually marketed are continuously checked by ISI for conformity to the standard. Details of conditions, under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6.3 Information to be Supplied by the Manufacturer — While submitting the samples for type tests, the following information shall be supplied by the manufacturer:

a) Manufacturer's name and address.

b) Catalogue of their product indicating the following information:

1) Range of manufacture;
2) Dimensional drawings including the mounting arrangement;
3) Contact materials and contact arrangement;
4) Category;
5) Sealed/non-sealed;
6) Working voltage and current (both ac and dc) with their rated load (resistive, inductive and motor);
7) Operating characteristics, that is, actuating force, release force, reset force, pretravel distance, overtravel distance, release travel distance and movement differential; and
8) Weight.

7. TESTS

7.1 Classification of Tests

7.1.1 *Type Tests* — The procedure for type tests shall be in accordance with IS : 2612-1965*.

Unless otherwise specified the manufacturer shall submit 30 specimens of sensitive switches of each category and electrical rating manufactured. Where more than one size are manufactured in the same electrical rating, the samples submitted for type approval shall be of the smallest size.

The sequence of type test shall be in accordance with Appendix A.

*Recommendation for type approval and sampling procedures for electronic components.

7.1.2 *Routine Tests* — The following tests shall be carried out on each and every switch:

a) General examination (**7.4.1**),

b) Electrical operation (**7.3.1**), and

c) Sealing (where applicable) (**7.8**).

7.1.3 *Acceptance Tests* — Acceptance tests shall be carried out on a limited number of samples selected in accordance with IS:2612-1965* and which have passed the routine tests. Two groups of samples, one for non-destructive tests (Group A) and the other for destructive tests (Group B), shall be selected and each group shall be subjected to the following tests in the order given below:

Group A (For Non-destructive Tests)

a) Contact resistance (**7.3.2**)

b) Voltage proof (high voltage) (**7.3.5**)

c) Insulation resistance (**7.3.4**)

Group B (For Destructive Tests)

a) Dimensions and weight (**7.4.2**)

b) Robustness of terminations (**7.4.5**)

c) Soldering (**7.4.4**)

d) Operating characteristics (**7.4.3**)

e) Bump (**7.4.7**)

f) Overload (**7.3.7**)

g) Climatic sequence (**7.7.1**)

7.2 General Conditions for Tests

7.2.1 *General* — The tests shall be carried out on the switches as received from the manufacturer or supplier. In no case shall the contact parts be cleaned or otherwise prepared prior to the tests unless explicitly so agreed.

7.2.2 *Selection of Samples* — The samples for testing shall be so selected as to be the representative of each type, category and rating.

7.2.3 *Atmospheric Conditions for Testing* — Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions as specified in IS: 589-1961†.

7.2.4 *Pre-conditioning* — Before measurements are made, the switches shall be stored at the measuring temperature for a time sufficient to allow the entire switch to reach that temperature. The recovery period called for after conditioning is adequate for this purpose.

*Recommendation for type approval and sampling procedures for electronic components.

†Basic climatic and mechanical durability tests for electronic components (*revised*).

7.2.5 *Mounting* — Where mounting is specified in a test, the switches shall be rigidly mounted on a metal plate using its normal fixing device, the dimensions of the mounting plate being such that the contour of the specimen under test is exceeded.

7.2.6 *Correction to be Applied* — When measurements are made at an ambient temperature other than the reference temperature, the results shall, where necessary, be corrected to that temperature. The ambient temperature during the test shall be stated in the test report.

7.2.7 *Drying* — Where drying is called for in this standard, the switches shall be conditioned, before measurement is made, for 96 ± 4 hours in a drying oven at a temperature of 55 ± 2°C. The switches shall then be allowed to cool in a desiccator using a suitable desiccant, such as activated alumina or silica gel and shall be kept therein from the time of removal from oven to the beginning of the specified test.

7.2.8 *Other Precautions* — During measurement, the switches shall not be exposed to draughts, direct sun-rays or other influences likely to cause error.

7.3 Electrical Test

7.3.1 *Electrical Operation* — The switch shall be connected to a circuit or circuits with suitable indicating devices and subjected to one or more cycles of operation as specified.

The electrical operation shall be satisfactory.

The switching characteristics shall be in accordance with the relevant specification.

7.3.2 *Contact Resistance*

7.3.2.1 *General measuring requirements* — Measurements may be carried out with direct current or alternating current. The contact resistance shall normally be calculated from the potential difference measured between each pair of associated terminations. The contact shall be made before the measuring voltage is applied. In order to prevent the breakdown of insulating film on the contact, the source emf shall not exceed 20 mV (dc or ac peak). In order to prevent undue heating of the contacts the current shall not exceed 1 A or the value specified by the relevant specification. For ac measurements the frequency shall be 1 kHz ± 200 Hz. The measuring apparatus shall be such as to ensure an accuracy of ± 10 percent.

7.3.2.2 *Measuring cycle (measurement with dc)* — One measuring cycle consists of:

a) making the contact,

b) connection of voltage source,

c) measurement with current flowing in one direction,
d) measurement with current flowing in the opposition direction,
e) disconnection of voltage source, and
f) breaking the contact.

7.3.2.3 *Measurement with ac* — One measuring, cycle consists of:

a) making the contact,
b) connection of the voltage source,
c) measurement,
d) disconnection of voltage source, and
e) breaking the contact.

7.3.2.4 *Measurement* — The contact resistance shall be measured between any two terminations that are to be connected by the switch. There shall be five measuring cycles. Measuring cycles shall be carried out in immediate succession.

7.3.2.5 *Requirements* — The value of the contact resistance for any individual measurement shall not exceed the value specified by the relevant specification.

NOTE — For low current contact for use in the microvolt range, modifications of the measuring method or special requirements or both may be specified by the relevant specification. When this test is required, the following details shall be specified:

a) Maximum value of the current, if other than 1 ampere; and
b) Maximum value of the contact resistance or maximum value of voltage drop.

7.3.3 *Variation of Contact Resistance*

7.3.3.1 *Method of measurement* — The variation of contact resistance shall be determined during the vibration test. The measurement of the contact resistance shall be made throughout the whole of the last frequency sweep in each direction.

The variation of contact resistance shall be determined by means of a cathode-ray oscilloscope (with a long persistance screen) displaying the potential difference between the points intended for the connection of wiring to the contact when a direct current of 10 ± 2 mA is passed through the contact. The source emf shall not exceed 20 mV.

The measuring apparatus shall:

a) have a frequency characteristic which is substantially flat between 400 Hz and 1 000 Hz with a decay below and above of not more than 3 dB at 70 Hz and 5 000 Hz.

b) be such as to ensure a measuring accuracy better than ± 20 percent, and

c) be calibrated with a sinusoidal voltage at 1 kHz.

The number of contacts to be tested and the severity of the vibration test shall be as specified by the relevant specification.

7.3.3.2 *Requirements* — The values of the voltages produced by variation of contact resistance shall not exceed the value specified by the relevant specification.

When the test mentioned in **7.3.3** is required by the relevant specification, the following details shall be specified:

a) Limit of the values of the voltage produed by variation of contact resistance,

b) Severity of the vibration test, and

c) Number of contacts to be tested and number of measurement.

7.3.4 *Insulation Resistance* — The insulation resistance shall be measured with the dc voltage 100 ± 15 V or 500 ± 50 V as specified by the relevant specification. The switch shall be mounted as specified in **7.2.5.** The insulation resistance shall be measured after an electrification time of 1 minute ± 5 seconds.

NOTE — When appropriate, the reading may be taken after a shorter period.

The measurement shall be carried out for each switching position between:

a) two adjacent terminations having minimum spacing, and

b) all terminations connected together and all other exposed metal parts.

7.3.4.1 *Requirement* — The value of the insulation resistance shall be not less than the value specified by the relevant specification.

When the insulation resistance test is required by the relevant specification, the following details shall be specified:

a) Value of the test voltage, and

b) Minimum value of the insulation resistance.

7.3.5 *Voltage Proof (High Voltage)* — Switches shall withstand without break-down or flash-over the voltage specified by the relevant specification. An ac test voltage shall be applied for one minute between the points indicated in **7.3.4.**

For points indicated in (a) of **7.3.4**, the value of the test voltage shall be as indicated in the relevant individual specification.

For points indicated in (b) of **7.3.4**, the relations between the rated voltage U_R (rms value) and the test voltage E (rms value) as is given below:

For switches with rated voltage above 34 V (peak):

$E = 2\ U_R + 1\ 500$ V with a minimum of 2 000 V

For switches with rated voltage below 34 V (peak):

$E = 500$ V

When this test is required by the relevant specification, the value of the test voltage shall be specified.

7.3.6 *Current Rating* — Each switch contact shall be capable of carrying its rated current for a period of 5 hours at the maximum category temperature without the rise in temperature at the terminations exceeding 20°C above the maximum category temperature.

7.3.7 *Overload* — Each switch contact shall be capable of making or breaking a circuit carrying a current 50 percent greater than the rating at a voltage 10 percent above the rated voltage (load resistive).

The test shall be applied 50 times at a rate of 5 cycles per minute, the duty cycle being 50 percent on and 50 percent off.

7.3.7.1 *Final measurements* — The switches shall then be subjected to the following tests and shall meet the requirements specified by the relevant specification:

a) Operating characteristics (**7.4.3**),

b) Contact resistance (**7.3.2**),

c) Voltage proof (**7.3.5**),

d) Sealing (where applicable) (**7.8**),

e) Insulation resistance (**7.3.4**), and

f) Internal examination — one sample of the switch shall be opened and internally examined.

7.3.7.2 There shall be no indication of mechanical damage, loosening of parts or extensive burning or pitting of contacts.

7.4 Mechanical Tests

7.4.1 *General Examinatian* — The switches shall be visually examined for the following:

The marking shall be in accordance with **6.**

The switch assembly shall be complete in accordance with the relevant drawing. Workmanship and finish shall be satisfactory. The switch shall be mechanically operable.

The metallic parts shall be properly treated/protected. Locking nuts where provided shall have well-formed threads and shall be of good running fit.

7.4.1.1 There shall be no visible deterioration after electrical, mechanical and climatic tests.

7.4.2 *Dimensions and Weight* — The dimensions and weight of the switch shall be checked and shall be in accordance with those specified in the relevant specifications for the type under test.

7.4.3 *Operating Characteristics* — The switch shall be mounted as specified in **7.2.5** and the following characteristics measured.

a) Actuating force,

b) Release force or reset force (as applicable),

c) Overtravel force,

d) Force differential,

e) Pretravel distance,

f) Overtravel distance,

g) Release travel distance,

h) Movement differential distance, and

j) Transit time.

7.4.3.1 The value shall be within the limits as specified in relevant specification.

7.4.4 *Soldering (Where Applicable)* — In order to determine the ability of the terminations to wet easily and to check that the switch itself will not be damaged by soldering processes, the switch shall be tested in accordance with **7.18** of IS:589-1961*.

After the test, there shall be no sign of mechanical damage or loosening of parts and the switch shall still be mechanically operable.

Where applicable, the following details shall be specified:

a) Method of test, including size of the soldering iron, where applicable; and

b) Period of recovery.

7.4.5 *Robustness of Terminations*

7.4.5.1 *Tensile test* — This test shall be carried out in accordance with **7.19.1** of IS:589-1961*. The loading weight shall be as specified in the relevant specification.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

7.4.5.2 *Bend test*—This test shall be carried out in accordance with **7.19.2** of IS:589-1961*. For teg terminations two consecutive bends shall be applied in accordance with **7.19.2.3** of IS:589-1961*.

7.4.5.3 *Torsion test on screw terminals*—This test shall be carried out in accordance with **7.19.4** of IS:589-1961*.

After each of these tests, the switch shall be visually examined. There shall be no sign of mechanical damage or loosening of parts and the switch shall still be mechanically operable.

When the test for robustness of terminations is required by the relevant specification, the following details shall be specified:

a) Tests to be carried out; and

b) Test conditions, such as values of the forces.

7.4.6 *Vibration*—This test shall be carried out in accordance with **7.6** of IS:589-1961* using the appropriate degree of severity. There shall be no measurements prior to the test, those which have been carried out during final measurements of the preceding tests shall be regarded as the initial measurment of the vibration test. The switch shall be mounted as specified in **7.2.5**. The following tests shall then be carried out:

a) The verification of opening of the contacts. The contact shall not open in excess of 10 μs.

NOTE — A continuous monitoring circuit is under consideration.

b) If specified, the variation of contact resistance.

7.4.6.1 After the test, the switch shall be subjected to the following tests indicated in order and shall meet the requirements of the relevant specification.

a) General examination (**7.4.1**), and

b) Operating characteristics (**7.4.3**).

7.4.6.2 When this test is required by the relevant specification, the following details shall be specified:

a) Severity of test,

b) Requirements for the variation of contact resistance, and

c) Final measurements.

7.4.7 *Bump*—The switches shall be subjected to the bump test in accordance with **7.5.1** of IS:589-1961* to a total of 4 000 bumps, the drop being 25 ± 4 mm with the switch mounted on the table of a bump test machine in the normal manner.

*Basic climatic and mechanical durability tests for electronic components (*revised*).

7.4.7.1 There shall be no spurious operation during the test.

NOTE — A continuous monitoring circuit is under consideration.

7.4.7.2 After the test, switch shall be subjected to the following tests indicated in order and shall meet the requirements of the relevant specification:

a) General examination (**7.4.1**),

b) Operating characteristics (**7.4.3**), and

c) Contact resistance (**7.3.2**).

7.4.7.3 When this test is required by the relevant specification, number of bumps in each direction shall be specified.

7.4.8 *Acceleration* — The switch shall be mounted on the table of accelerating machine and connected in a circuit with a suitable indicating device such as a lamp which will indicate momentary spurious operation during the test.

7.4.8.1 The switches shall be subjected to acceleration test in accordance with **7.7** of IS:589-1961*, using the appropriate degree of severity.

7.4.8.2 There shall be no spurious operation during the test.

7.4.8.3 After the test, the switch shall be subjected to the following tests indicated in order and shall meet the requirement of the relevant specification:

a) General examination (**7.4.1**),

b) Operating characteristics (**7.4.3**), and

c) Contact resistance (**7.3.2**).

7.4.8.4 When this test is required by the relevant specification, the severity of the test shall be specified.

7.4.9 *Shock* — The switch shall be mounted on the table of a shock testing machine and connected in a circuit with a suitable indicating device such as a lamp which will indicate momentary spurious operation during the test.

7.4.9.1 The switches shall be subjected to shock test in accordance with **7.5.2** of IS: 589-1961* using the appropriate degree of severity.

7.4.9.2 There shall be no spurious operation during the test.

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7.4.9.3 After the test, the switch shall be subjected to the following tests indicated in order and shall meet the requirements of the relevant specification:

a) General examination (**7.4.1**),

b) Operating characteristics (**7.4.3**), and

c) Contact resistance (**7.3.2**).

7.4.9.4 When this test is required by the relevant specification, the severity of the test shall be specified.

7.5 Transit Time Test

7.5.1 *Test Method* — The switch shall be mounted as specified in **7.2.5**. Any of the methods specified in **7.5.1.1** or **7.5.1.2** may be used.

7.5.1.1 *Method A* — The actuator shall be moved at a uniform speed by any suitable means through the operating and release (or reset) positions of the switch (*see also* **B-2**).

7.5.1.2 *Method B* — The switch shall be oriented so that the actuating force is in the direction of gravitational force. The actuator shall be operated by a weight equal to the specified actuating force. For biased switches, it shall be allowed to release by the reduction of this weight to a weight equal to the specified release force. For non-biased switches, it shall be reset by a weight equal to the specified reset force.

7.5.2 *Monitoring Methods* — Any suitable monitoring method may be used in evaluating the value of the transit time.

A suitable monitoring method for sensitive switches with 3 or 4 terminations per pole (changeover switches) is shown in Appendix B (Fig. 3).

NOTE — More than one fixed contact being available for connection, it is possible to measure the transit time by means of connections to the switch contacts.

A suitable monitoring method for sensitive switches with two terminations per pole (on/off switches) is shown in Appendix B (Fig. 4). In this method the switch is operated through a pressure sensing capsule as a means of detecting the portion of the snap action.

NOTE — Only one fixed contact being available for connection, it is not possible to measure the transit time solely by means of connections to the switch contacts.

7.5.3 *Number of Measurements* — The transit time shall be measured for 5 cycles through the operating and release or (reset positions), that is, 10 values of transit time shall be obtained.

7.5.4 *Requirements* — The maximum value of the transit time detained during the 5 cycles through the operating and release (or reset positions) shall not exceed the value shown in the relevant individual specification.

7.5.5 *Summary* — When this test is required by the relevant specification, the following details shall be specified:

a) Method of test,

b) Speed of operation of the actuator in Method A,

c) Values of operating and release (or reset) force in Method B, and

d) The maximum value of the transit time.

NOTE — Transit time when checked at a given actuator operating speed gives measurable definition of 'snap-action', and as defined above, is a repeatable characteristic of any given switch. Further definitions and tests may be required for contact bounce and chatter which are less repeatable characteristics (*see* Appendix B, Notes 1 and 2).

7.6 Short-Circuit Test — The switch shall be inserted in a circuit (*see* Fig. 2) calibrated to give 60 times the rated resistive load. With the circuit-breaker and the switch under test in a closed position, the circuit shall be closed manually by a third switch (control switch). The circuit breaker shall be adjusted to interrupt the circuit 100 ms after the specified current flows. The test shall be conducted 5 times. A minimum of 2 minutes shall elapse between the successive operation of the control switch.

At the end of this test, there shall be no contact weld or stick and there shall be no mechanical damage to the switch. The contact resistance shall be measured and shall be within the value specified in the relevant individual specification.

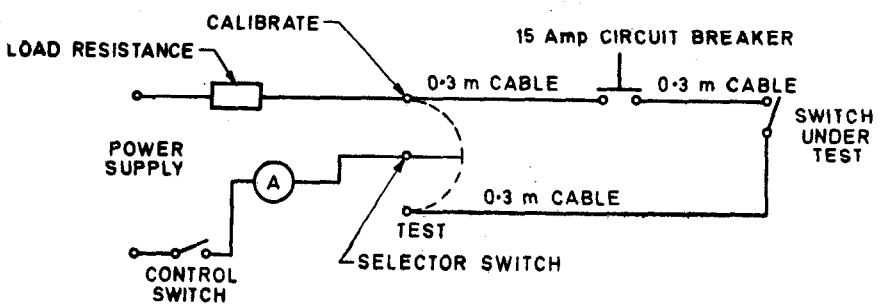

FIG. 2 TYPICAL TEST CIRCUIT FOR SHORT-CIRCUIT TEST

7.7 Climatic Test

7.7.0 *General* — Where applicable, the switch shall be mounted as specified in **7.2.5**. In each test the final measurement stated shall be carried out in the order stated.

7.7.1 *Climatic Sequence*

7.7.1.1 *Dry heat* — This test shall be carried out in accordance with **7.2** of IS:589-1961*, using the appropriate degree of severity. While still at the high temperature, the insulation resistance shall be measured and shall be not less than the values specified by the relevant specifications. During the last 5 hours of the dry heat test, current rating test may be carried out.

In addition, while switches are at the high temperature, there shall be a check that the switch is mechanically operable.

At the end of the dry heat test, the switches shall be removed from the chamber and exposed to standard recovery conditions appropriate to this test.

7.7.1.2 *Damp heat (accelerated) (first cycle)* — The switches shall be subjected to the first cycle of this test in accordance with **7.4** of IS:589-1961*. After the specified period of conditioning, the switches shall be removed from the chamber and allowed to remain under standard recovery conditions appropriate to the test.

After recovery, the switches shall be visually examined. There shall be no corrosion or mechanical deterioration or any other visible damage. The marking shall be legible.

7.7.1.3 *Cold* — This test shall be carried out in accordance with **7.1** of IS:589-1961*, using the appropriate degree of severity. While still at the low temperature there shall be a check that the switch is mechanically operable. The switches shall then be removed from the chamber and exposed to the standard recovery conditions, appropriate to the test.

The switches shall then be visually examined and they shall show no sign of deterioration.

7.7.1.4 *Low air pressure* — This test shall be carried out in accordance with **7.12** of IS:589-1961*, using the appropriate degree of severity. The test chamber shall be maintained at a temperature of 15 to 35°C. The duration of the test shall be 5 minutes.

During the test, a potential equal to 1·5 times the rated voltage dc or ac (rms) shall be applied between the points mentioned in **7.3.4**.

During and after this test, there shall be no sign of glow discharge, break-down, flashover or harmful deformation of the switch.

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7.7.1.5 *Damp heat (accelerated) (remaining cycles)* — The switches shall then be subjected to remaining number of cycles of this test in accordance with **7.4** of IS : 589-1961*.

NOTE — Remaining damp heat cycles required are as follows:

Category I — 5 cycles

Category II — 5 cycles

Category III — 1 cycle

The switches shall then be removed from the chamber and exposed to standard recovery conditions appropriate to this test.

7.7.1.6 *Final measurements* — The switches shall then be subjected to the following tests and shall meet the requirements specified by the relevant specification:

a) General examination (**7.4.1**);

b) Working test (within 15 minutes) after removal from the chamber: the switch shall be connected to a load as specified in the relevant specification and operated 5 times by hand. The operation shall be satisfactory;

c) Insulation resistance (**7.3.4**);

d) Voltage proof (high voltage) (**7.3.5**);

e) Contact resistance (**7.3.2**);

f) Sealing (where applicable) (**7.8**); and

g) Operating characteristics (**7.4.3**).

7.7.2 *Damp Heat (Long Term Exposure)* — This test shall be carried out in accordance with **7.3** of IS : 589-1961*. The duration of exposure shall be appropriate to the category of the switch. After the expiry of the above period, the switches shall be removed from the chamber and exposed to standard recovery conditions appropriate to this test.

7.7.2.1 *Final measurements* — The switches shall then be subjected to the following tests and shall meet the requirements specified by the relevant specification:

a) General examination (**7.4.1**),

b) Working [**7.7.1.6** (b)],

c) Insulation resistance (**7.3.4**),

d) Voltage proof (high voltage) (**7.3.5**),

e) Contact resistance (**7.3.2**),

f) Sealing (where applicable) (**7.8**), and

g) Operating characteristics (**7.4.3**).

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7.7.3 *Rapid Change of Temperature* — This test shall be carried out in accordance with **7.14** of IS : 589-1961*. The total number of cycles for Categories I and II shall be five. The switches shall then be removed from the chamber and exposed to standard recovery conditions appropriate to this test.

7.7.3.1 *Final measurements* — The switches shall then be subjected to the following tests and shall meet the requirements specified by the relevant specification:

a) General examination (**7.4.1**),
b) Working [**7.7.1.6** (b)],
c) Insulation resistance (**7.3.4**),
d) Voltage proof (high voltage) (**7.3.5**),
e) Contact resistance (**7.3.2**),
f) Sealing (where applicable) (**7.8**), and
g) Operating characteristics (**7.4.3**).

7.8 Sealing (Where Applicable) — This test shall be carried out in accordance with **7.15** of IS : 589-1961*. When this test is required by the relevant specification, it shall specify all details for test procedures together with requirements.

7.9 Mould Growth — The switches shall be subjected to mould growth test in accordance with **7.9** of IS : 589-1961*.

After the expiry of the specified period of exposure, there shall be no mould growth on the switches visible to the naked eye.

7.10 Salt Mist — The switches shall be subjected to salt mist test in accordance with **7.10** of IS : 589-1961*. The period of exposure being four days.

After the expiry of the test, the switches shall be removed from the chamber and subjected to the following tests and shall meet the requirements specified in the relevant specification:

a) General examination — there shall be no corrosion or damage and the markings shall remain legible,
b) Working [**7.7.1.6** (b)],
c) Insulation resistance (**7.3.4**),
d) Contact resistance (**7.3.2**), and
e) Operating characteristics (**7.4.3**).

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7.11 Dust — The switches shall be placed in a dust chamber and dust test shall be carried out in accordance with **7.11** of IS : 589-1961*.

7.11.1 At the expiry of the test, the switches shall be removed from the chamber and subjected to the following tests indicated in order and shall meet the requirements specified in the relevant specification:

a) General examination (**7.4.1**),

b) Contact resistance (**7.3.2**), and

c) Operating characteristics (**7.4.3**).

7.12 Endurance

7.12.1 *General* — The switches shall be operated mechanically to make and/or break the currents specified in **7.12.2** at a rate of 15 to 20 cycles per minute.

A cycle consists of moving the actuator from the free position to the total travelled position and return to the free position.

The total travelled position of the actuator shall correspond to a point not less than 50 percent of the over-travel of the apparatus but not more than 80 percent. The return shall not be free.

The actuating element outside the apparatus (example : cam) shall remain in permanent contact with the actuating element of the apparatus.

Return from momentary actuated position shall be accomplished solely by the internal switch mechanism.

For double-throw switches, one half of the lot of switches shall be tested with the circuit connected to one set of contacts and the remaining half of the lot with the circuit connected to the other set of contacts.

For multipole switches, each pole of the switch shall be tested simultaneously with the other pole(s).

If the electrical rating of a switch covers more than one combination of voltage and current, the tests shall be carried out with the maximum rated voltage and the associated rated current.

Arrangements shall be made to ensure that the switches correctly switch 'on' and/or 'off' when they are operated.

7.12.2 *Test* — The test shall be carried out at normal air pressure and at the maximum temperature appropriate to the category of the switch. The number of operations shall be 100 000 in each of the following cases,

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unless otherwise specified in the relevant specification:

a) *Inductive circuit*:

1) The test shall be carried out using an inductive circuit with the dc voltage and current as specified in the relevant specification.
2) The circuit used for this test shall have a time constant between 2 and 3 ms.
3) The duty cycle shall be approximately 25 percent 'on' and 75 percent 'off'.

b) *Lamp load*:

1) The tests shall be carried out using a lamp load with the voltage and current as specified in the relevant specification.
2) For switches having a dc or dc/ac rating, the test shall be carried out with dc.
3) For switches having an ac rating only, the test shall be carried out with ac.
4) Only tungsten lamps each of which having a nominal power not exceeding 25 W at the voltage specified by the relevant specification shall be used for the load.
5) The duty cycle shall be approximately 25 percent 'on' and 75 percent 'off'.

c) *Resistive circuit*:

1) The test shall be carried out using a resistive circuit with the ac voltage and current as specified in the relevant specification.
2) The duty cycles shall be approximately 50 percent 'on' and 50 percent 'off'.

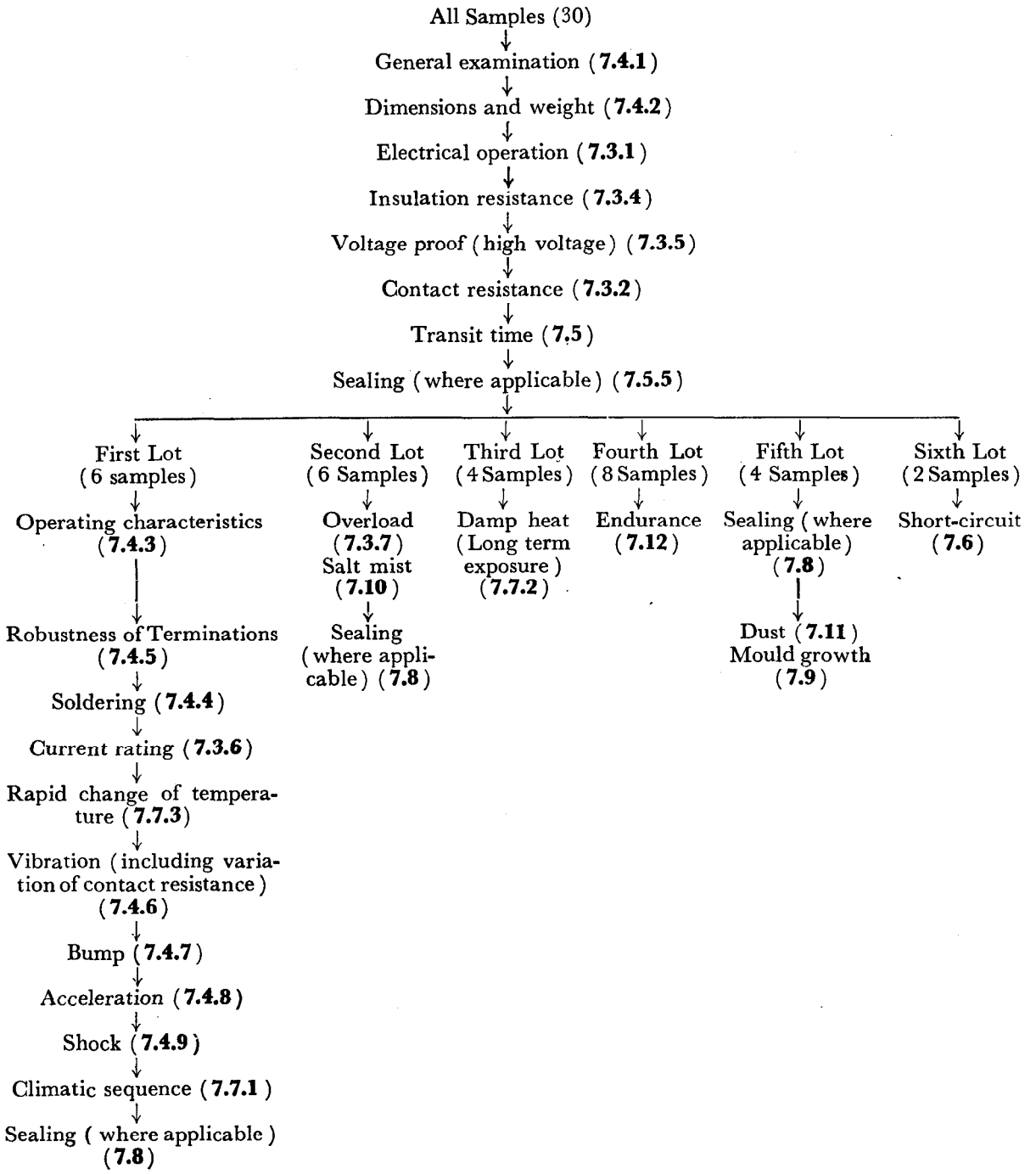
d) *Final measurements* — The switches shall then be subjected to the following tests and shall meet the requirements specified by the relevant specification.

1) General examination (**7.4.1**),
2) Operating characteristics (**7.4.3**),
3) Contact resistance (**7.3.2**),
4) Insulation resistance (**7.3.4**),
5) Voltage proof (high voltage) (**7.3.5**), and
6) Sealing (where applicable) (**7.8**).

APPENDIX A

(*Clause* 7.1.1)

SEQUENCE OF TYPE TESTS



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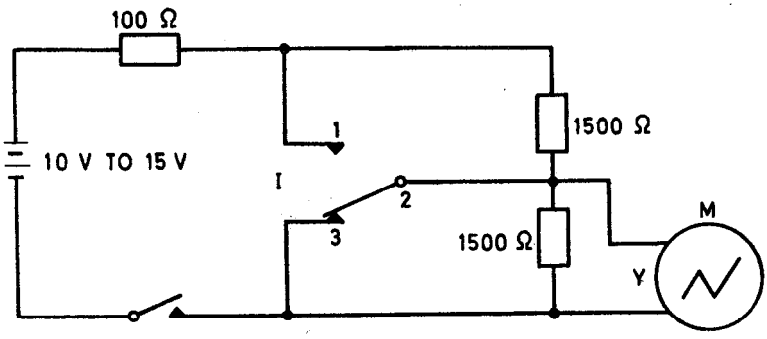
APPENDIX B

(*Clause* 7.5.2)

TRANSIT TIME MONITORING METHOD

B-1. TRANSIT TIME MONITORING METHOD FOR CHANGEOVER SWITCHES WITH THREE OR FOUR TERMINATIONS PER POLE



I = Switch under test, with three terminations (changeover switch with common contact).

M = Suitable storage-type oscilloscope, time calibrated.

NOTE — In the case of a switch with 4 terminations, this is tested by connecting termination 4 to termination 2 as follows:

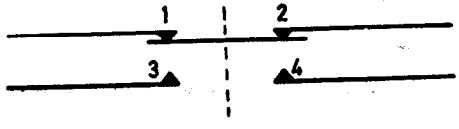
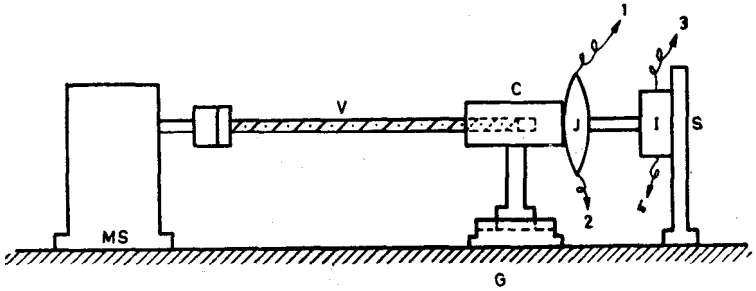


FIG. 3 ARRANGEMENT FOR TRANSIT TIME MONITORING (SWITCHES WITH 3 OR 4 TERMINATIONS PER POLE)

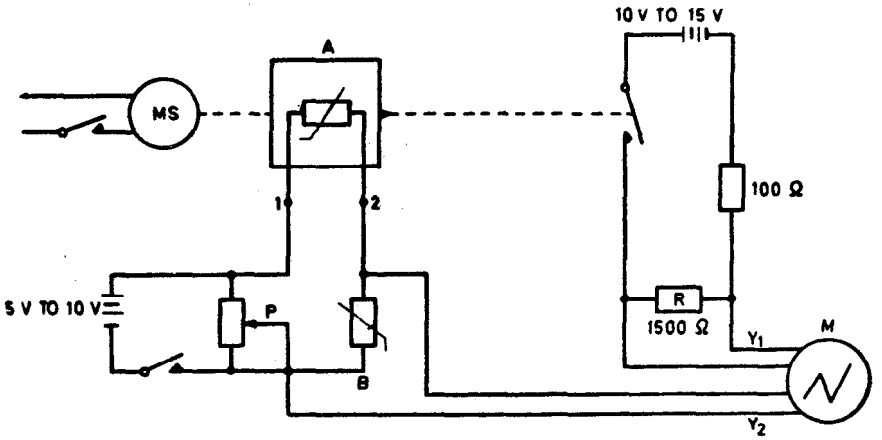
B-2. TRANSIT TIME MONITORING METHOD FOR SWITCHES WITH TWO TERMINATIONS PER POLE

B-2.0 General — The monitoring method in this appendix is shown combined with test Method A (*see* **7.5.1.1**).

B-2.1 Mechanical Arrangement — as shown in Fig. 4.



MS = Synchronous hysteresis motor, bidirectional, of known speed, working off an ac supply;
V = Micrometer screw with known, suitable pitch;
C = Moving carriage on fixed slide *G*, actuated by the screw *V*;
J = Pressure pickup mounted on the carriage and interposed between it and the actuating member of the switch under test *I*;
S = Suitable fixed support for the switch under test; and
I = Switch under test (with two terminations).



MS = Synchronous hysteresis motor, bidirectional, of known speed, working off an ac supply;
A = Pressure pickup integral with carriage (strain gauge inside a deformable enclosure);
B = Control strain gauge;
P = Potentiometer set so as to balance the bridge when there is no pressure on the actuating member of the switch *I* (when balanced, the output voltage of the bridge is zero and the spot is not deflected); and
M = Double-beam storage-type oscilloscope, time calibrated.

FIG. 4 ARRANGEMENT FOR TRANSIT TIME MONITORING (SWITCHES WITH TWO TERMINATIONS PER POLE)

B-2.2 Method — Prior to determining transit time, the following measurements are performed (*see* Fig. 4):

a) The linear speed of the carriage C as a function of the speed of rotation of the motor and the pitch of the micrometer screw; these parameters are chosen so as to be suitable for the transit time.

b) The response of the pressure pickup.

Taking the above factors into account, the transit time is determined by measuring with the oscilloscope the variation in voltage at the terminals of the pickup A (input Y_2), and at the terminals of the resistor R (input Y_1) (*see* Fig. 4).

NOTE 1 — Every time the contact bounces, this is registered on the oscilloscope, since each bounce produces a variation in pressure detected by the pressure capsule.

NOTE 2 — The indications obtained using this method are similar to that given in Fig. 5.

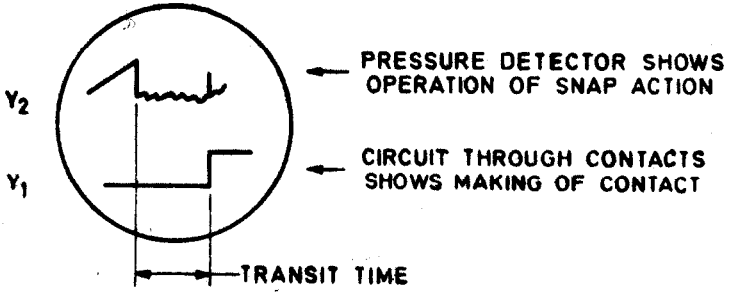


FIG. 5 INDICATION OF TRANSIT TIME

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